DOCUMENT RESUME

ED 276 074 CS 505 411

AUTHOR	Milosky, Linda M.; And Others
TITLE	School-Age Children's Understanding of Explanation Adequacy. Final Report.
PUB DATE	1 Nov 85
NOTE	38p.
PUB TYPE	Reports - Research/Technical (143)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Classroom Communication; *Communication Research; Comprehension; Developmental Stages; Elementary Education; Grade 3; Grade 5; *Instructional Effectiveness; Learning Processes; Mathematics; Peer Relationship; *Problem Solving; *Student Needs

ABSTRACT

A study examined developmental differences in students' recognition of the types of explanations that help most in mathematics peer-group interactions. Scripted interactions of eight male and eight female dyads working on math problems were videotaped. In each interaction one actor in the dyad would request non-specific assistance and the other would provide one of four types of responses: (1) answer, (2) procedure, (3) procedure and justification, or (4) procedure and demonstration. Subjects, 62 third and fifth graders, worked on each of the math problems, were shown the videotape of the dyad working on the same problem, then rated the degree to which they thought the reply helped the other actor to understand the math work. Sixty adults who read the scripts of the interactions also indicated how much they thought the response helped the other actor. Results indicated age-related differences in children's differentiation among different types of replies to requests for information. Older subjects made greater distinctions between replies that only provided them with an answer and those that provided them with information about the process of problem solving. In addition, older subjects were better able to verbalize this distinction. They referred more often to the need for a response that contained information that would teach them the process and allow generalization to future math problems. Appendices provide girl and boy scripts for 3rd and 5th grade stimuli and a description of the coding system for justification of subject's ratings. (HTH)

School-Age Children's Understanding of Explanation Adequacy

Linda M. Milosky
University of Utah

Louise Cherry Wilkinson
City University of New York-Graduate School

Chi-Pang Chiang
Janet Lindow
Diane Salmon
University of Wisconsin-Madison

Final report of a study as specified in Students Communicative Competence in Instructional Contexts. November 1, 1985.

Third and Fifth-grade Students' Perceptions of Explanation Effectiveness

Introduction

Students' learning in classrooms depends to some extent on their communicative skills, since communication mediates learning. For example, students' understanding of what constitutes a helpful, informative explanation facilitates their use of explanations to aid their learning. The present study assessed that understanding by examining developmental differences in school-age students' evaluations of explanations.

Some observational studies of classrooms have examined students' production of explanations during small-group math seatwork (e.g., Peterson, Janicki, & Swing, 1981; Swing & Peterson, 1982; also see Webb, 1982 for detailed review). These studies have typically focused on the relationship of certain small-group behaviors (e.g., requests, explanations, answer-checking) to achievement. Variables that appear to influence the strength of this relationship include the type of explanation offered (e.g., an answer, explication of the process, information about small-group procedure) (Peterson, Wilkinson, Spinelli, & Swing, 1984; Swing & Peterson, 1983) and whether it was solicited or not (Webb, 1982). Milosky and Wilkinson (1984) found that second and third grade children's responses to requests for information elicited few explanations. Of 126 requests for information which could be characterized as soliciting an explanation from the listener, only 10% actually received one. Along these same lines, Cazden, Cox, Dickinson, Steinberg, & Stone (1979) reported that students in a combined first-second third grade classroom had difficulty explaining an academic task to peers even when the teacher had instructed and rehearsed the prospective student-tutor. Peterson et al. (1984) speculate that second and third graders are not capable of giving detailed explanations describing the mathematical processes involved in problem-solving due to the lack of "higher-order explanations" in their findings. Cooper and Cooper (1984) offer several reasons for age-related differences in children's explanations. Children, indeed, may not have acquired the ability to explain. They may be able to give an explanation, but can not do so because of other demands in a given situation. A third reason may be that they may not recognize when a explanation is needed or what type of explanation is best. This third constraint was the focus of the present study.

Only one study has examined students' evaluations of explanations provided during small-group math work (Peterson & Swing, 1985). A stimulated-recall paradigm was used to assess second- and third-grade students' judgments about the adequacy of explanations offered during small-group math seatwork (Peterson & Swing, 1985). Students watched videotaped segments of interactions that had occurred while they worked on the math problems in small groups and were asked the following questions: (a) "Did (receiver's name) understand what (Provider's name) said?" and (b) "Was that a good way for (provider's name) to explain the answer to (receiver's name)"?. Students who answered "no" to question (b) were then asked "What is a better way to explain?". On the average, 69% of students in each group judged the initial explanation to be adequate. "Better" ways to explain focused either on providing more information/different content or on pragmatic/paralinguistic qualities. While this study did require children to evaluate messages about academic content, by its nature, it could not control for construction of the message, the speaker, or social/affective factors.

A more controlled, direct examination of children's judgments of message adequacy has occurred in some referential communication studies. Robinson (1981) reported that 5-year-old children typically blamed the "listener" for failure on the referential communication task. Specifically, when messages were inadequate, ambiguous, or only partially informative, children rated the speaker as having done a good job while they attributed the listener's incorrect selection of the referent to nonattending or misinterpretation of the message. While listener-blaming occurred consistently among the 5-year-olds, 7-year-olds sometimes blamed the speaker. Interestingly, the 11-year-olds consistently blamed the speaker. It could be that children of different ages use different criteria for judging communication effectiveness. For example, Beal and Flavell (1982) found that young children's judgments of communication adequacy were influenced by the listener's indicated comprehension. Messages that were not adequate to allow task completion were judged adequate by children when the listener indicated comprehension. While these studies have examined children's ability to identify a message as inadequate, they have not required children to distinguish among messages of differing degrees of adequacy (Sonnenschein, 1985).

The present study was designed to elicit judgments of academic message adequacy in a controlled study. We examined age-related differences in children's recognition of the type of explanation that are most helpful in math peer-group interactions. These judgments, or ratings of effectiveness, were elicited using videotaped stimuli that did not require children to provide or receive the message. Lloyd, Baker and Dunn (1984) have suggested that videotaped stimulus presentation may enhance metacognitive assessment because there are fewer performance demands placed on the child. In order to explore the basis on which children judged message helpfulness, we asked them for justification of their ratings. This allowed the determination of how children related the content of the message to the perceived needs of the listener.

Method

Subjects

Sixty-two students, thirty-one each from the third and fifth grades of a midwestern public elementary school, participated in the study. There were 18 girls and 13 boys in each grade level. All students had normal language and hearing abilities and demonstrated no learning or emotional disabilities. The students were from monolingual, middle SES homes, and were recruited voluntarily through parental permission letters.

In order to determine how adults would respond to the experimental task, 60 adult volunteers were recruited to participate in a modified version of the study.

Stimulus Material

Sixteen videotaped interactions were presented depicting dyads of elementary school students working together on math problems. The children who appeared on the tapes (henceforth referred to as actors) were recruited from a local theater school and their interactions were scripted (see Appendix A). They were not aware of the purpose of the research. Two tapes were prepared, one consisting of eight interactions portrayed by a dyad of males and the other involving eight interactions of a dyad of females. Each interaction showed the actors working on a problem from a math problem sheet. The interactions were videotaped at an angle that provided minimal views of the actors' faces in order to reduce the effects of variations in facial expression across trials. After one actor read the problem aloud, the dyad worked on it for a short period, and then one actor would request assistance from the other using an indirect, non-specific request form (e.g., "I don't get this.") The other actor then provided one of four types of responses to the request. These stimulus responses were modelled after actual audiotaped conversations obtained in an earlier study of interactions during small group learning in the classroom (Peterson, et al., 1984) The length of responses was controlled within each set of four, so that any judgment biases related to length would average out across trials. The four types of responses were:

1. Answer - These responses provided the solution to the problem although they specifically did not use the word "answer." "Let's see. Yeah. I get 4667 kilometers for that one."
2. Procedure - These responses provided the operation necessary for completing the problem. "You have to subtract to do that one."
3. Procedure and justification - These responses provided the operation necessary for completing the problem and the reason that operation was appropriate. "You know that it's addition because it asks for the total weight."
4. Procedure and demonstration - These responses provided the operation necessary for completing the problem and indicated the necessary components. "You subtract this one, 165 (points) from this one, 215 (points.)"

Two levels of stimuli were created, one for the third grade students and one for the fifth. Each level consisted of 16 problems which were selected from math work in the school's curricula. Third grade students received problems from the second grade curriculum and fifth grade students received problems from the fourth grade curriculum. This was done to ensure that students would be familiar with the material presented, and that each group of students would experience the same relative difficulty in the problem sets.

The following procedure was used to determine the order of presentation of the stimuli. Order of presentation of response types was counterbalanced across blocks of four (e.g., first block: answer, procedure, procedure +

justification, procedure + demonstration; second block: procedure, procedure + justification, procedure + demonstration, answer; etc.). Two tapes for each grade level were generated--one of the male dyad and one of the female dyad. Each dyad portrayed eight interactions per grade level. Within one tape of eight interactions, there were two blocks of four response types. Each child-actor gave each response type once, and the block in which they gave it (first or second block of four) was randomized within response type. For the adult verification of the experimental task, the 60 adult subjects were given written versions of the scripts.

Procedure

Students were examined individually in a small, quiet room within the school. An expressive language sample was obtained in order to determine students' expressive language abilities and to familiarize them with the experimenter. Experimental trials then were administered with order of presentation of the tapes counterbalanced across subjects. Following administration of the experimental trials, comprehension portions of the Test of Language Development--Intermediate (TOLD-I) (Hammill & Newcomer, 1982) were administered to screen for language comprehension abilities.

The following instructions were given to students prior to the experimental trials:

> This is not a test. There are no right or wrong answers. You will not be graded on how you do. We just want to find out how you think about certain things. I'm going to show you a movie. This movie shows boys and girls working together in their math groups on their math problems. Do you ever work together in small groups in your class? Well that's what these boys and girls are doing. Their teacher told them to help each other and that if one person doesn't understand the problem, to ask the other person for

help. The children are supposed to help each other understand the math work. When I show you the movie of the children working together, I'm going to ask you to be a judge. Do you know what a judge does? (Following student's reply): That's right, just like in the Olympics--a judge decides about somebody's performance. Here when you're a judge you will decide how much one person helped the other person to understand the math work.

In order to familiarize the students with the rating scale procedure, they were given a seven point scale reflecting food preferences. The labels for the points of the scale were constructed to parallel those to be used on experimental trials (don't like at all, like only a little, like a lot, etc.). The students then were asked to name foods that corresponded to each of the points (e.g., their favorite food, a food they liked a great deal, a food they didn't like at all, etc.) and the experimenter recorded these above each of the points. They then were given another scale with just the labeled points and were asked to rate three foods that the experimenter named.

The following instructions were then read:

Now we're going to watch the boys and girls working together. Remember, their teacher has told them to help each other understand the math work. Here's the judging scale we're going to use. Let's look at each of the points of the scale.

The experimenter read the points aloud with the subjects. The points on the scale were: did not help at all to understand, did not help much to understand, helped only a little to understand, helped some to understand, helped pretty much to understand, helped a lot to understand, and helped totally to understand. Then the students were presented with the first math problem and were asked to solve it. They then were shown the videotaped interaction and were asked to indicate on the scale how much they thought the reply helped the other person to understand the math work. Students were asked to solve each math problem before the interaction was presented; they were presented with a new rating scale for each interaction. In addition to noting the rating the student assigned to the response, the examiner recorded whether or not the students had solved the problem correctly. The students also were asked to justify their ratings for the first eight interactions.

Adult subjects each reviewed a booklet containing either the third or the fifth grade script. Each page of the booklet contained one interaction (the story problem, a non-specific request for information, and an explanation) and a rating scale like those presented to the students. The adults were asked to indicate on the scale how helpful they thought the reply was to the student seeking help in the scripted interactions.

<u>Coding of Justifications</u>

The students' justifications of their ratings were transcribed and coded. Three levels of justifications were distinguished (see Table 1). These levels reflected the degree to which the student focused on specific content of the explanation in terms of its ability to aid the listener in understanding the problem. Level 3 justifications made specific references to the ways in which the explanation did or didn't help the listener to understand. These included justifications which indicated the importance of what was said for future understanding, justifications which referred to the reasoning behind the problem, and those which referred to how to carry out the problem. Level 2 justifications made less reference to the specific content of the stimulus explanation. They either referred to the general quantity of the information, to interpersonal characteristics of the interactants, took a personal focus, or referred to the general quality of the explanation. Level 1 justifications simply restated the interaction in vague or general terms. These justifications also included those reflecting incorrect interpretations of the interaction or irrelevant responses. Justifications were coded independently by two experimenters. Inter-rater agreement was 88% (see Appendix B). All the students' rating justifications were also coded on the basis of whether or not they matched the rating given.

Insert Table 1 here

Results

Number of Problems Correct

The number of problems the students solved correctly was computed in order to determine if problem difficulty affected how students judged the interaction about the problems. These scores were analyzed in a 2 (grades) x 4 (types) ANOVA, with grade level the between-subjects factor and reply type the within-subjects factor. In general, students performed the problems correctly. They averaged more than three problems right out of four in each set (mean = 3.36). Results of ANOVA indicated that there was no grade effect or interaction effect between grade and reply type. This suggested that third and fifth grade students were equally familiar with their respective problems sets. However, the effect of reply type was significant ($F = 3.44$; $df = 3,180$; $p < .01$). The problems followed by justification replies were solved correctly less frequently than those followed by answer replies (3.16 vs. 3.52 problems correct.)

Student Ratings of Reply Types

Mean ratings for the different reply types are displayed in Figure 1. The internal consistency of these ratings was determined by calculating Cronbach's alpha. The consistency range for different reply types for third grade students was .75 to .95, and for fifth grade students was .33 to .90. The ratings were analyzed in a 2 (grades) x 4 (types) ANOVA, with grade level the between-subjects factor and reply type the within-subjects factor. Results of this analysis are displayed in Table 2. The effect of reply type was significant ($F = 100.49$; $df = 3,180$; $p < .01$). Post-hoc pairwise comparisons revealed that answer replies were rated significantly lower than procedure ($\underline{S} = 10.57$; $p < .01$), justification ($\underline{S} = 13.43$; $p < .01$), and demonstration replies ($\underline{S} = 16.17$; $p < .01$). Ratings of procedure replies were significantly lower than justification ($\underline{S} = 2.86$; p .05) and demonstration replies ($\underline{S} = 5.59$; $p < .05$). There was no significant difference between ratings of justification and demonstration replies.

Insert Table 2 and Figure 1 here

The interaction effect between reply type and grade was also significant ($F = 5.08$; $df = 3,180$; $p < .01$). The only post-hoc comparison to yield a significant result was that contrasting the difference between answer and justification in third and fifth grade students. There was a greater difference in the fifth grade than in the third grade between answer replies and the justification ones ($\underline{S} = 3.85$; $p < .01$). This suggested that as children get older, they are more likely to view justification replies as more helpful than answer replies.

<u>Adult Validation</u>

Figure 2 illustrates the mean ratings obtained from adults for the third- and fifth-grade request-reply sequences. The internal consistency of these ratings was determined by calculating Cronbach's alpha for each set of stimuli (third and fifth grades.) The range for different reply types for third grade stimuli was .77 to .90 and for fifth grade stimuli was .85 to .92. The ratings were analyzed in the same way as the children's ratings. Results of this analysis are displayed in Table 1. The lack of a grade effect or an interaction effect between grade and reply type was not unexpected. This provided further confirmation of the equivalency of the stimulus sets presented to third and fifth grade students. The effect of reply type was significant ($F = 129.70$; $df = 3,174$; $p < .01$). Post-hoc pairwise comparisons revealed essentially the same pattern as that obtained from the children's ratings. Answer replies were rated significantly lower than procedure ($\underline{S} = 12.61$; $p < .01$), justification ($\underline{S} = 17.75$; $p < .01$), and demonstration replies ($\underline{S} = 16.22$; $p < .01$). Ratings of procedure replies were significantly lower than those of justification ($\underline{S} = 5.14$; $p < .01$) and demonstration replies ($\underline{S} = 3.60$; $p < .01$). There was no significant difference between ratings of justification and demonstration replies.

Insert Figure 2 here

<u>Students' Justifications of Their Ratings</u>

As justifications were requested on eight trials, each student provided two justifications for each of the four reply types. Students' justifications on the two trials were combined for each reply type. Figure 3 illustrates, for each grade, the mean level of justifications for each reply type. To evaluate the differences between grades, two types of analyses were performed.

Insert Figure 3 here

The Friedman Test, which is appropriate for the ordinal nature of justification data, was used to examine justifications for the different types of replies within each grade. Third grade students did not vary the kind of justification they offered across reply types. However, fifth grade students did ($\chi^2 = 10.07$; $df = 3$; $p < .05$). Post-hoc pairwise comparisons revealed that they gave relatively lower level justifications for their ratings of demonstration replies compared with the justifications they offered for ratings of answer replies ($S = 2.90$; $p < .05$). Although direct comparison across grades could not be made, these results suggested that fifth grade students had more differentiated evaluations than third graders.

In the justification data, only 32 level-3 justifications (specific content) occurred out of 480 (two third-grade students justifications were lost due to equipment malfunction during the experiment). However, proportionally, significantly more of the fifth-grade students provided at least one level-3 justification compared with the third-graders (41% vs. 10.3%) ($\chi^2 = 6.12$; $df = 1$; $p < .05$). Fifth-grade students (mean = 5.77) also used Level-2 justifications (general content) more frequently than the third-graders (mean = 4.66) ($t = 2.05$; $df = 58$; $p < .05$). These results illustrate a developmental difference in the specificity and sophistication of children's knowledge about explanations.

Discussion

The findings of this study suggest age-related differences in children's differentiation among different types of replies to requests for information. As children get older, they make a greater distinction between replies which only provide them with an answer and those that provide them with information about the process of problem solution. In addition, the findings suggest that older children are more able to verbalize this distinction. They referred more often to the need for a response to contain information which would teach them the process and allow generalization to future math problems.

When we considered the combined results of ratings and justifications, we saw two possible components to the developmental difference in children's ratings. First, their awareness of the importance of specifity for helpful explanations may have increased. Second, their perceptions of the goals of math group interactions may have changed. Older children were more aware of the need to discuss process as well as product (or answer) in order to generalize learning to future situations. Although third-grade students, in general, did rate answers and other types of replies differently, their justifications for their ratings were less explicit about why an answer was not as helpful. One possibility is that their generally lower rating of answers may have resulted from teachers' frequent injunctions about "not just copying your neighbor's answers." Certainly, the third-grade students seemed less aware of the relevance of present discussion to future applications, as indicated by the fact that they referred less frequently to the future in their justifications.

Third grade students may have been more likely to focus on the immediate situation, with the perceived goal being completion of the problems. In contrast, fifth graders more frequently may have perceived the goal in terms of their long-range needs in learning. Secondary analysis of the ratings of answers revealed that on 24% of answer trials, third-grade students judged this reply type as "helping pretty much," "a lot" or "totally" while only 2.4% of fifth-grade students did so. The perception, by some third graders, of answers as the only end-goals of the problems was reflected in the use of the highest rating "helped totally" for such replies. This rating was used by third graders 12.9% of answer trials, it was only used once (.8%) by one fifth grader. The third graders' justifications for these high ratings reflect this concern with a more immediate goal. When asked why they had rated the answer reply a 7 ("helps to understand totally), justifications included "Because she told the answer and she just listens and then she can write it down," and "Wel' she explained it really good and the other girl knew the answer right away." In contrast, fifth graders, when giving answers poor ratings stated reasons such as "She did tell the answer for that one, but if she comes to another problem similar to that one she still won't understand anything" and "Because she just gave the answer, she didn't help to understand. If she wasn't there and she was given another problem she wouldn't know how to do it even if it was just like that."

References

Beal, C., & Flavell, J. (1983). Young speakers' evaluations of their listener's comprehension in a referential communication task. Child Development, 54, 148-153.

Cazden, C., Cox, M., Dickinson, D., Steinberg, Z., & Stone, C. (1979). "You all gonna hafta listen": Peer teaching in a primary classroom. In W. A. Collins (Ed.), Children's language and communication: Twelfth Annual Minnesota Symposium on Child Psychology. Hillsdale, NJ: Lawrence Erlbaum.

Cooper, C. R., & Cooper, R. G. (1984). Skill in peer learning discourse. In S. A. Kucgaz (Ed.), Discourse Development. New York: Springer-Verlag.

Hammill, D., & Newcomer, P. (1982). Test of Language Development. Austin, TX: Pro-Ed.

Lindow, J. (in press). Elementary students' verbal disagreements during small-group interaction. Journal of Educational Psychology.

Lloyd, P., Baker, E., & Dunn, J. (1984). Children's awareness of communication. In C. Garvey, L. Feagans, & R. Golinkoff (Eds.), The origins and growth of communication. Norwood, NJ: Ablex Publishing Co.

Milosky, L., & Wilkinson, L. Cherry. (1984, November). Requests for information and responses obtained in classroom learning groups. Paper presented at the annual meeting of American Speech and Hearing Association, San Francisco, California.

Peterson, P. L., Janicki, T. C., & Swing, S. R. (1981). Ability x treatment interaction effects on children's learning in large-group and small-group approaches. American Educational Research Journal, 18, 453-473.

Peterson, P. L., & Swing, S. (1985). Student's cognitions as mediators of the effectiveness of small-group learning. Journal of Educational Psychology, 77, 299-312.

Peterson, P., Wilkinson, L., Spinelli, F., & Swing, S. (1984). Merging the process-product and sociolinguistic paradigms: Research on small-group processes. In P. Peterson, L. Wilkinson, & M. Hallinan (Eds.), The social context of instruction: Group organization and group processes. New York: Academic Press.

Robinson, E. (1981). The child's understanding of inadequate messages and communication failure: A problem of ignorance or egocentrism? In P. Dickson (Ed.), Children's oral communication skills. New York: Academic Press.

Sonnenschein, S. (1985). The development of referential communication skills: Some situations in which speakers give redundant messages. Journal of Psycholinguistic Research, 14, 489-508.

Swing, S., & Peterson, P. L. (1982). The relationship of student ability and small-group interaction to student achievement. American Educational Research Journal, 19, 159-274.

Webb, N. (1982). Student interaction and learning in small groups. Review of Educational Research, 52, 421-445.

Wilkinson, L., & Calculator, S. (1982). Requests and responses in peer-directed reading groups. American Education Research Journal, 19, 107-120.

Table 1

Justification Levels and Subcategories

Level 3: Specific Reference to the Content of the Explanation

- Specifies Future Understanding--(e.g., "Because when he's not with him or they're taking a test, then he's not going to know how to do it.")
- Specifies Why--(e.g., "Because he told him just what to do, and he explained why.")
- Elaborated Explanation--(e.g., "Because he told him what the answer was, but he didn't tell him how to do it or explain at all what he was supposed to do to get the answer.")
- Nonelaborated Explanation--(e.g., "Because he told him just what he needed to do.")

Level 2: Less Specific Reference to the Content of the Explanation

- General Quantity Statement--(e.g., "He told him to add those two numbers and that wasn't quite as much as he told the other guy.")
- Interpersonal Characteristics--(e.g., "She didn't say it very nice.")
- Personal Focus--(e.g., "Well I didn't understand it.")
- General Quality Statement--(e.g., "She explained it really good.")

Level 1: [illegible] or Incorrect Restatements of Interaction

- [illegible]atement of Interaction--(e.g., "She told him to add the numbers [illegible]her.")

ble 2

alysis of Variance Table for Ratings of the Reply Types

	3rd and 5th Grade Children				Adults			
ırce	df	Sum of Squares	Mean Square	F	df	Sum of Squares	Mean Square	F
:ween Groups								
;rade	1	1.65	1.65	.65	1	4.89	4.89	1.35
;rror 1	60	153.39	2.56		58	210.71	3.63	
hin Groups								
ype	3	357.71	119.24	100.49**	3	260.39	86.80	129.70**
rade by Type	3	18.08	6.03	5.08**	3	4.75	1.58	2.37
rror 2	180	213.57	1.19		174	116.44	.67	

Appendix A

Girl and Boy Scripts for 3rd and 5th Grade Stimuli

Third Grade Boys Stimuli

Al: Margo the magician. Margo is a great magician. Her magic shows are full of tricks and surprises. Work the problems and find out the kinds of magic tricks Margo does. You read.

Pete: Margo pulled 12 rabbits out of her hat. Then she pulled 21 kittens out of her hat. How many more kittens than rabbits did she have?

(pause)

Pete: Huh? I just don't get it.

Al: Well, you just subtract one from the other.

****

Pete: Go ahead.

Al: Margo did a rope trick. One rope was 38 centimeters long. The other was 46 centimeters long. How many centimeters of rope in all?

(pause)

Al: I don't know about this one. I'm confused.

Pete: You add this one, 38 (points), and this one, 46 (points), together.

****

Pete: Margo made 18 playing cards fly through the air. Then she made 13 more cards fly. How many cards flew through the air altogether?

(pause)

Pete: This one's tough. I can't do it.

Al: Uh, let's see. Oh! I get 31 for that one.

****

Al: Ok let's see. Margo took off her hat and 23 birds flew out. Then 16 rabbits jumped out. How many more birds than rabbits were there?

(pause)

Al: This one's hard. I don't get it.

Pete: See? It's subtraction because it says "how many more than."

****

Pete: Clem the clown. Clem is the funniest clown in the circus. He can make you laugh even when you feel cross. The problems tell you how he does it.

Al: Clem fell off his horse 14 times. He fell off a swing 20 times. How many more times did he fall off the swing?

(pause)

Pete: Huh? I don't know about this one.

Al: Here's the 20 (point) and here's the 14 (point) and you subtract.

****

Pete: Clem threw 19 pies at another clown, Pete. Pe'e threw 26 pies at Clem. How many more pies did Pete throw?

(pause)

Pete: I can't do this one.

Al: You're supposed to subtract because it says "how many <u>more</u> pies."

****

Pete: Read, Al.

Al: Clem fell on his nose 18 times. He fell on his seat 14 times. How many falls in all?

(pause)

Al: I don't understand.

Pete: Well, you just add the number of falls together.

****

Al: Go, Pete.

Pete: Clem tripped over a rope 14 times. He tripped over a box 17 times. How many times did he trip?

(pause)

Al: I don't know how to do this one.

Pete: I can do it in my head. It's 31!

Third Grade Girls Stimuli

Tina: Becky is a big, furry bear. Becky and her brother love to take honey from bees' nests. But one day some bees caught them! Work the problems to find out what happened.

Sue: The bees chased Becky 25 meters. They chased her brother 17 meters. How many more meters did they chase Becky?

(pause)

Sue: That's a tough one. I don't get it.

Tina: Oh, you have to subtract because they ask "how many more meters did they chase Becky."

****

Sue: Your turn Tina.

Tina: They stung Becky 9 times. They stung her brother 13 times. How many times did the children get stung altogether?

(pause)

Sue: Hmmm, I can't get this one.

Tina: I get it! The children get stung by the bees 22 times altogether.

****

Tina: You read this one Sue.

Sue: Becky hid in the river for 73 minutes. Her brother hid for 44 minutes. How many more minutes did Becky hide?

(pause)

Tina: I don't understand this one.

Sue: I do. You just take away the 44 (points) from the 73 (points).

****

Tina: The bears swam 36 meters. Then they ran 25 meters. How far did they go altogether?

(pause)

Sue: I can't do this one.

Tina: On that one I think...yeah! you need to add the numbers together.

****

Sue: Here's a new set of problems. Jean and Roy's mother owns a pet store. Jean and Roy often help her at the store. Do the problems and see if you would like to work in a pet store.

Tina: Jean put 16 baby chicks in a box. Roy put 14 more chicks in the box. How many chicks in all?

(pause)

Tina: I don't get this one.

Sue: Oh! I know what it is. It's 30 baby chicks in all.

****

Tina: Go ahead Sue.

Sue: Jean and Roy fed 27 puppies. Then they fed 18 kittens. How many more puppies than kittens did they feed?

(pause)

Tina: It's hard. I'm not sure about this.

Sue: I see. You have to subtract on that one to get the answer.

****

Tina: Roy gave the turtles 26 bugs. Jean gave the turtles 32 bugs. How many more bugs did Jean give the turtles?

(pause)

Tina: I'm confused on this one.

Sue: You subtract because you want to find out how many more bugs Jean gave.

****

Sue: It's mine now. One day 23 mice got out of their cage. Then 26 more mice got out. How many mice got out?

(pause)

Sue: Huh? I don't get it.

Tina: OK, you have to add this one, 23 (points), and this one, 26 (points), together.

Fifth Grade Boys Stimuli

Al: The Washington School Hobby Club has a sale to raise money every year. Solve these problems to see what they sell. You read first.

Pete: Elena had $16.50. She spent $3.79 at the sale. How much money did she have left?

(pause)

Pete: I don't understand this problem.

Al: I do. You have to take away this one, $3.79 (points) from this one, $16.50 (points), to get it.

****

Al: Mike bought a fish tank for $15.08. He also bought a filter for $5.85. How much did he spend?

(pause)

Al: This is hard. I can't do it.

Pete: Listen, you need to add the prices together to get the right answer to that one.

****

Al: You read the next one.

Pete: Jason likes books. He bought a mystery for $3.19 and a dictionary for $5.96. How much did he spend?

(pause)

Pete: I can't figure this one out.

Al: Ok, you're supposed to add on that one because they ask for how much spent.

****

Al: Sally bought a paint brush for $.94. Then she bought a football for $8.58. How much more did she pay for the football?

(pause)

Pete: Huh? I don't get it.

Al: Oh, that's easy. She paid $7.64 more for the football than for the paint brush.

****

Al:	Your turn Pete.
Pete:	Animal populations which are rapidly decreasing in number are considered endangered species. Solve these problems and see which populations they are.
Al:	There are 126 whooping cranes. If the number of whooping cranes increases by 19, how many will there be?

(pause)

Al:	That's a tough one. I don't get it.
Pete:	Well, you need to add on that one, because you want to know how many there will be, and it says increase.

****

Pete:	I'll read again.
Pete:	The population of sea otters is 2196. The population of Bighorn sheep is 315. What is the difference between otters and sheep?

(pause)

Al:	I don't understand this one.
Pete:	You just subtract this one, 315 (points), from this one, 2196 (points) to solve it.

****

Pete:	You go this time.
Al:	The population of bald eagles is 3842. There are 126 whooping cranes. What is the difference between eagles and cranes?

(pause)

Al:	I can't do this problem. It's hard.
Pete:	I think I know. There are 3716 more bald eagles than whooping cranes.

****

Pete:	There are 956 right whales. If the number of right whales increases by 105, how many will there be?

(pause)

Pete:	I don't think I can get this one.
Al:	OK, listen. You need to add the numbers in that problem in order to figure it out.

Fifth Grade Girls Stimuli

Tina: The members of the Hot Air Balloon Club take many trips in their balloons. Solve these problems to see where they go.

Sue: The club's balloon traveled 2429 kilometers one year and 2238 kilometers the next year. How many kilometers did it travel in all?

(pause)

Tina: I don't understand.

Sue: Let's see. Yeah! I get 4667 kilometers for that one.

****

Tina: I'll do this one. One passenger in Double Eagle weighed 59 kilograms. The other passenger weighed 87 kilograms. What was the total weight of the passengers?

(pause)

Tina: That one's tough. I can't do it.

Sue: You know--it's addition because it asks for the total weight.

****

Tina: This one's yours.

Sue: The balloon club had 372 members the first year. The next year, it had 521 members. How many more members were there, in the second year?

(pause)

Sue: Huh? I don't know about this one.

Tina: Well, you just do subtraction to get the answer.

****

Tina: The sunshine balloon rose to a height of 165 meters. Double Eagle rose to a height of 215 meters. How much higher did Double Eagle rise?

(pause)

Sue: I don't get this.

Tina: You subtract this one, 165 (points), from this one, 215 (points).

****

Sue: Here's a new one. Detective Dan and Detective Diane solve mysteries together. See if you can solve them too!

Tina: Diane searched for some missing money and found $16.47. Dan searched and found $25.81. What was the difference between what they found?

(pause)

Tina: Huh? I just don't get it!

Sue: Let's see. The problem will have a minus sign in it.

****

Sue: When Dan bought a secret-code book in 4th grade it cost $4.29. When he went back the next year, the price increased by $2.25. How much is the new price?

(pause)

Sue: I don't think I know how to do this.

Tina: This one's not too hard! It cost $6.54 the next year.

****

Tina: This one's mine. Dan had a treasure box with $84.99 in it. Diane added what she had found to the box and increased the treasure by $61.28. How much money was in the treasure box altogether?

(pause)

Tina: I don't know how to do this.

Sue: OK. It's this one, $61.28 (points) plus this one, $84.99 (points).

****

Sue: Here goes. Diane bought a flashlight for $3.68. Then she bought a magnifying glass for $8.25. How much more expensive was the magnifying glass?

(pause)

Sue: Huh? I just don't get it!

Tina: You see, you've supposed to subtract because it asks you "how much more."

Appendix B

Coding System for Justifications

Coding System for Justification

The justifications which subjects offered for their ratings were classified as one of nine possible types. These categories were organized into three different levels. The following guidelines were used by the two independent coders in classifying the justifications.

Conventions

1. Subject justifications ranged from specific to vague in their identification of the reason why the stimulus explanation was or was not helpful. The coding categories were ordered from 9 to 1 in an effort to reflect this continuum, 9 being the most specific reason and 1 the most vague. Higher level codes overrode lower level codes. If a justification contained more than one type of code, it was assigned the highest level code that it contained. (In the examples following the category definitions, applications of this convention are illustrated. A response containing multiple types of justifications is listed as an example of the highest level type. Lower level codes are embedded in the justification in parentheses.)

2. The subject's entire justification is considered when coding, regardless of the number of experimenter prompts that occurred.

3. Coders referred to the scripts containing the explanations when coding the content of the justifications. It was necessary to refer to the type of stimulus explanation which the child was responding to in order to accurately classify the justification.

4. Coders listened to the audiotapes when coding justifications which appeared to be borderline between two or more categories.

5. In addition to content codes, justifications were also coded on whether they were consistent or not with the rating which the child gave to the explanation. Justifications which generally matched ratings were coded _1_ (e.g.,

Rating of 6; Justification, "Because he told him what to do and he explained why"). Both the justification and the rating were positive. Justifications which did not seem to match the ratings which were given were coded 0 (e.g., The child provided a negative justification but assigned a high rating to the explanation, or vice versa).

Coding Categories

Level 3 Subcodes

Specifies Future Understanding--Justifications which focused on the listener's ability or lack of ability to solve/understand the problem outside of the present context.

Example: "Because then when he's not with him or they're taking a test, then he's not going to know how to do it."

Specifies Why--Justification which specified the presence or absence of a justification or reason for why the problem should be solved in a particular manner. These justifications focused on the reasoning behind the problem.

Example: "Because he told him just what to do, and he explained why".

Elaborated Explanation--Justifications which told "what" to do or "how" to do it by identifying a procedure in contrast to another or by referring to the steps involved in carrying out a procedure. These justifications specified what the stimulus explanation did or didn't do to aid understanding. Inclusion in this category was determined by the stimulus explanation as well as the justification response (e.g., "Answer" stimuli require less elaboration of "how" or "what" than the other three stimuli).

Examples: ANS -- "Because he told him what the answer was, but he didn't tell him how to do it or explain at all what he was supposed to do to get the answer."

ANS -- "Well he didn't tell him anything, he just said that's easy, I can do it in my head, and then he told the answer, but he didn't tell how to do the problem at all."

PRO -- "Well he sort of told him what to do, but he didn't show him or explain it through, he just told him quickly what he was supposed to do."

DEM -- "He told him the things he had to do to subtract."

DEM -- "Well that's really the major part of the problem just to know <u>what</u> to do."

JUS -- "Well he actually didn't know what to do with this subtraction, it's kinda hard to explain, but he just told him it's subtraction, but he didn't know what to do with the subtraction, and he thought what do I subtract from something."

JUS -- "Well because she told him he was supposed to subtract." (prompt) "Because he might have put down times or something."

<u>Nonelaborated Explanation</u>--Justifications referred to the presence or absence of some type of explanation of how the problem could be done or what the problem requires. This reference was stated in general terms so that it is clear that the subject was referring to the need for an explanation of the problem, but the specifics of the explanation were not delineated. These justifications went beyond repetitions of the exchange because they abstracted the notion that an explanation was necessary, but were not specific about what the explanation should do.

<u>Examples</u>: ANS -- "Well he didn't get it, and then he just put down the answer, and he didn't tell him anything about it."

PRO -- "Because he told him just what he needed to do."

DEM -- "Well she told her how to solve the problem and that it would be pretty easy to solve just after you knew how to do the problem."

JUS -- "Well if the girl was having problem with adding it or was having problems with, at all, she really needed to know was how to do the problem, and that was by adding."

Level 2 Subcodes

General Quantity Statement--Justifications which were a general statement referring to the quantity of information in the explanation. It indicated that there is either enough or not enough information on the explanation to be helpful.

Example: "He just told him to add those two numbers which wasn't quite as much as the other kid told him."

Interpersonal Characteristics--Justifications which referred to interpersonal characteristics of the explainer which either aided or detracted from the helpfulness of the explanation.

Example: "Because all she said was the problem' ll have a minus sign in it (9), and she's kinda saying that to herself, she wasn't really even talking to the other girls". (6)

Personal Focus--Justifications which contained the personal pronoun I and made reference to the subject's own ability to understand/solve the problem based upon the information given in the explanation.

Example: C: "Well because she didn't really help her understand the problem, I didn't really understand it (7), and she didn't explain it really good." (8) Experimenter: "What wasn't good about the explanation?" C: "Well I didn't understand it." (7)

General Quality Statement--Justifications which made reference to the general quality of the explanation using such descriptors as "good", "ok", or "helped pretty much", "poor".

Example: "Well because she explained it really good, and the other girl knew the answer right away."

Level 1 Subcodes

Nonelaborated or Incorrect Repetitions, Irrelevant Responses--Justifications which simply restated the interaction in vague or general terms. They lacked reference to the presence or absence of an explanation in terms of "what" or "how" and any reference to quantity or quality. Exact repetitions were not necessary. Incorrect repetitions were general statements attempting to restate the interaction viewed on the tape, however, they were inaccurate. Irrelevant responses focused on aspects of the problem or the interaction which were not related to understanding the math.

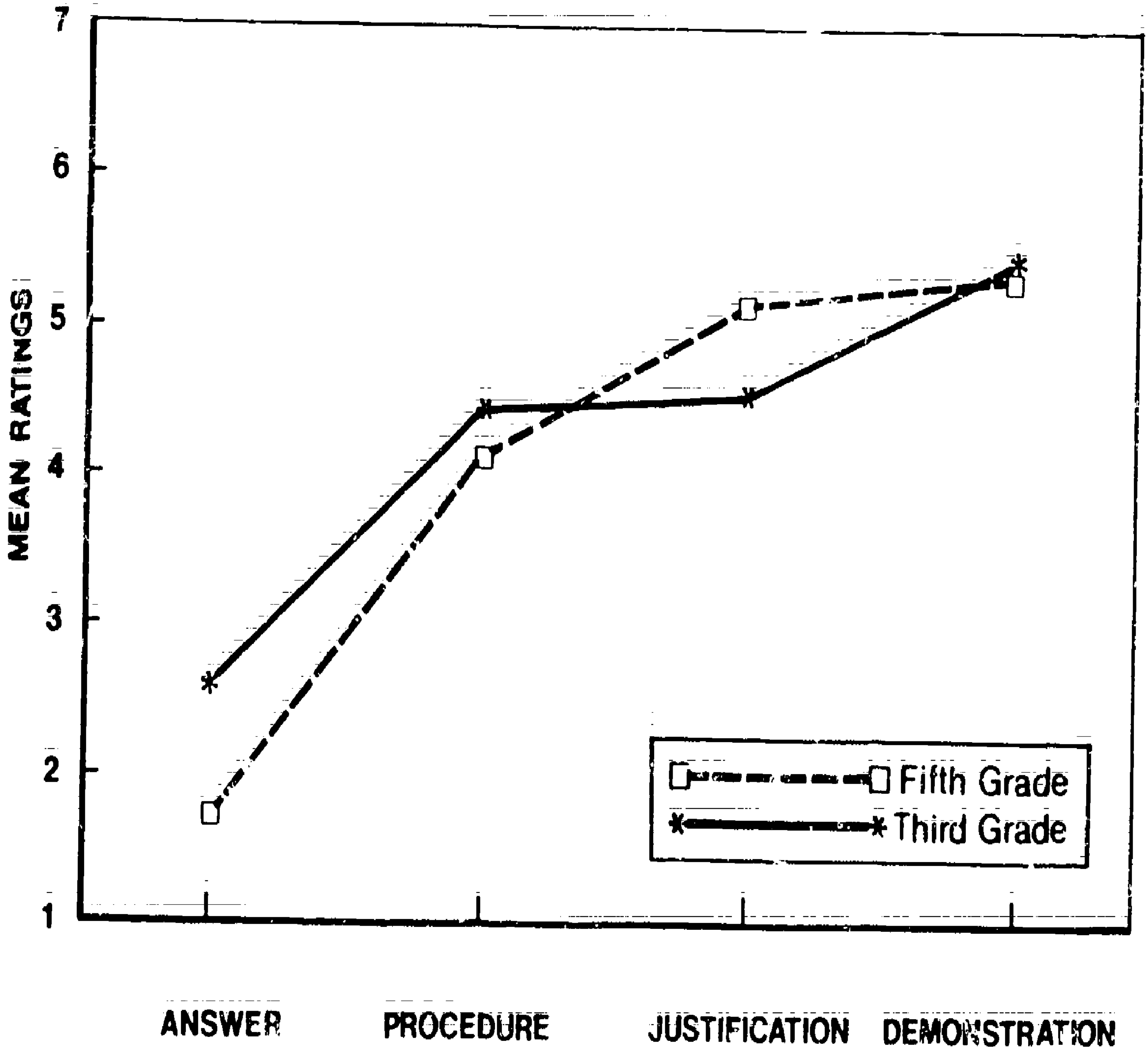
Examples: ANS -- "Well because she helped her to figure out the answer." (prompt) "Well so she can write it down and get the answer."

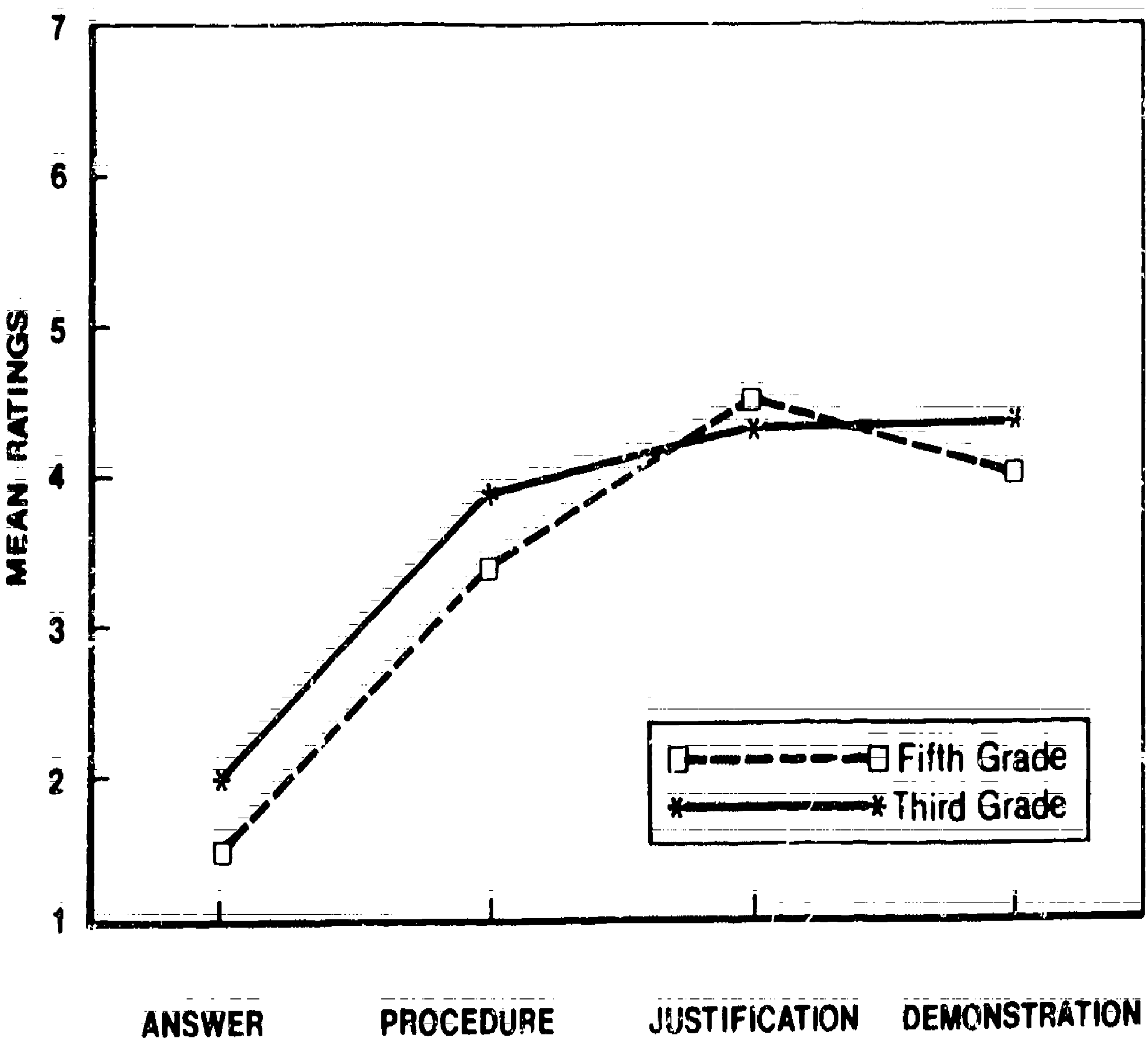
PRO -- "Well he told him that you just add the two together and then you get out the answer."

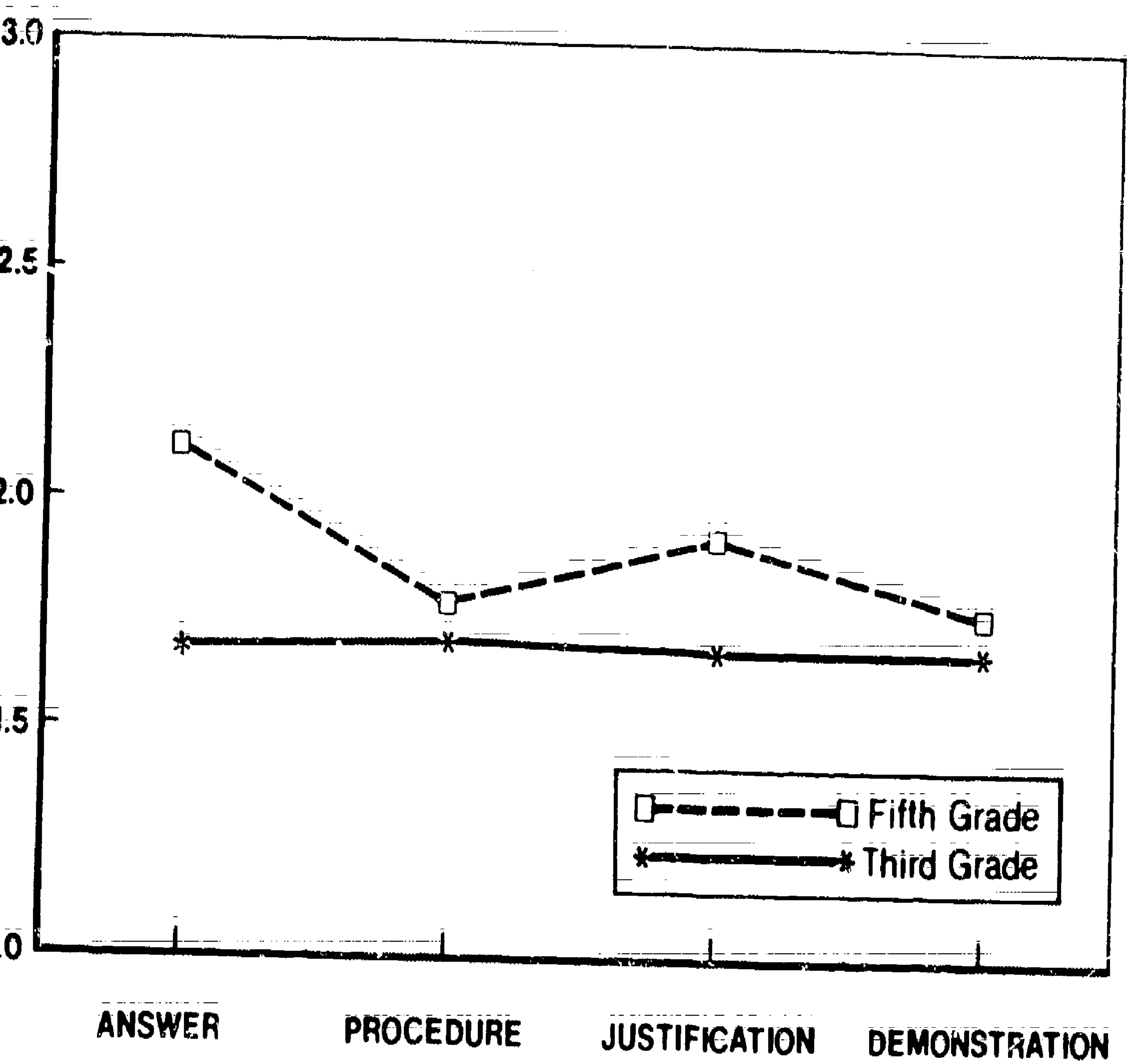
DEM -- "Because he told him twenty take away fourteen and then he just has to subtract and do the answer."

DEM -- "Well he didn't even tell him what to do with the answer that he came out with, is he just supposed to stay there, or does he have to do something with it or something, he doesn't know what to do with the answer."

JUS -- "Well he told you have to take away that time, and he just wrote down twenty six take away nineteen, and then you would have to take away and just find the answer."


7
6
5
4
3
2
1
MEAN RATINGS
Fifth Grade
Third Grade
ANSWER
PROCEDURE
JUSTIFICATION
DEMONSTRATION


7
6
5
4
3
2
1
MEAN RATINGS
Fifth Grade
Third Grade
ANSWER
PROCEDURE
JUSTIFICATION
DEMONSTRATION


3.0
2.5
2.0
1.5
1.0
Fifth Grade
Third Grade
ANSWER
PROCEDURE
JUSTIFICATION
DEMONSTRATION